19990614 015

14. SUBJECT TERMS symposium, dynamics, control 15. NUMBER OF PAGES 11. 16. PRICE CODE				
Symposium, dynamics, control	14. SUBJECT TERMS			15. NUMBER OF PAGES
	symposium, dynamics, control		11	
				16. PRICE CODE
17. SECURITY CLASSIFICATION 18. SECURITY CLASSIFICATION 19. SECURITY CLASSIFICATION 20. LIMITATION OF ABSTRACT	17. SECURITY CLASSIFICATION		19. SECURITY CLASSIFICATION	20. LIMITATION OF ABSTRACT
OR REPORT ON THIS PAGE OF ABSTRACT UNCLASSIFIED UNCLASSIFIED ULL		· · · · · · · · · · · · · · · · · · ·		111
NSN 7540-01-280-5500 Standard Form 298 (Rev.2-89)		ONCLASSIFIED		

Prescribed by ANSI Std. 239-18 298-102

Final Report for:

11th VPI&SU Symposium on Structural Dynamics and Control F49620-97-1-0303

This grant was in support of the conference titled: "Eleventh VPI&SU Symposium on Structural Dynamics and Control". This symposium was held on the campus of Virginia Tech, in Blacksburg, VA, from May 12 – 14, 1997. The conference consisted of 65 papers being presented over a three-day period. The results of the conference have been published in a bound volume titled *Structural Dynamics and Control*. This work clearly acknowledges the support of AFOSR in the preface.

The symposium was organized and run by Prof. L. Meirovitch of our Engineering Science and Mechanics Department. The conference was viewed as a successful exchange of research ideas in structural dynamics and control by all who attended. The table of contents and preface of the proceedings are attached. An attendees list is also appended.

The goal of the meeting was to spark enthusiastic technical exchange in the areas of dynamics and control in a single session environment with ample opportunity for verbal exchange between the delegates. This was accomplished.

PREFACE

With a 40% increase in the number of papers compared to 1995, the Eleventh Blacksburg Symposium demonstrated once again the appeal of this highly-focused conference. Presentations included analytical and experimental developments in structural dynamics and control from a variety of engineering disciplines. particularly well represented were the areas of seismic control of structures, noise control, aeroservoelasticity, control of robots, smart structures, multibody systems, flexible manipulators and control of space structures.

Many thanks are due to D. J. Inman, Symposium Co-Chairman, who helped with the organization of the symposium, as well as to A. M. Baz, R. L. Clark, A. E. Finzi, M. I. Friswell, J. Olsen, R. D. Quinn, M. P. Singh, L. N. Virgin and J. N. Yang for organizing special sessions.

Very much appreciated was the support from Dr. S. C. Liu, National Science Foundation, and Major B. Sanders, Air Force Office of Scientific Research.

Special thanks are due to Norma B. Guynn for her significant help in putting this volume together.

Blacksburg, Virginia December 1997 L. Meirovitch Symposium Chairman and Proceedings Editor

TABLE OF CONTENTS

High Performance Control of Buildings Under Seismic Excitation Designs for Saturating Actuators
T. Nguyen, F. Jabbari and S. de Miguel
Seismic Response Control of Asymmetric Torsional Building Structures
M. P. Singh, E. E. Matheu and C. Beattie
Fuzzy Logic Control of Structures with Hybrid Seismic Isolation Systems
M. D. Symans and S. W. Kelly
The Practical Limits of Damage Detection and Location Using Vibration Data
M. I. Friswell and J. E. T. Penny
Finite Element Model Updating, a Link Between Two Worlds: Where Should it be Located?
M. W. Zehn and O. Martin41
Experimental Validation of Semi-Active Devices for the Control of Building Vibrations
B. Rose, P. B. Shing, D. M. Frangopol, S. D. Kang and N. Kermiche
Control of a System with Variable Frequency
S. Nagarajaiah and S. Wang61
Integrated Reduced-Order Controller for MDOF Systems Using Ensemble Training
R. Betti, H. Lus, G. F. Panariello and R. W. Longman71
Sliding Mode Control of Civil Structures Using Dynamic Output Feedback
JC. Wu and J. N. Yang
A Methodology for Finite Element Model Updating Using Modal Data
C. Papadimitriou, M. Levin-West and M. Milman91
Design and Mechanics of an Antagonistic Biomimetic Actuator System
R. M. Kolacinski and R. D. Quinn
Self-Diagnostic Actively Controlled Structures
A. S. Naser, M. J. Schulz, P. F. Pai, S. K. Thyagarajan and H. Zhang
ER Material Models and Vibration Control
H. P. Gavin

Control of Base-Isolated Structures in Earthquakes
L. Meirovitch and T. J. Stemple
Impedance Studies of Active Interior Noise Control Systems
V. Jayachandran and J. Q. Sun143
An Acoustic Boundary Control Method with Actuator Grouping for Interior Noise Suppression
S. M. Hirsch and J. Q. Sun
Feedback Control of Broadband Sound Radiation from a Rectangular Plate
W. Dehandschutter, K. Henrioulle, J. Swevers, P. Sas and P. Van Overschee
Semiactive Control of Structural Resonance
M. Ahmadian, X. Song and B. A. Reichert
Free Vibrations of Axially Extendible Sliding Beams
K. Behdinan and B. Tabarrok181
Motion Controller for the K ² T, Inc. Crab-Like Robot
W. C. Flannigan, G. M. Nelson and R. D. Quinn
Active Vibration Control of Free and Forced Oscillation of a Flexible Beam
F. Fariborzi, F. Golnaraghi and G. R. Heppler199
A Nonlinear Variable Stiffness Feedback Control with Tuning Range and Rate Saturation
T. Kobs and J. Q. Sun
An Integrated Friction Model with Improved Presliding Behaviour
C. Ganseman, J. Swevers, F. Al-Bender and T. Prajogo
A Nonlinear Method for Vibration Control of Flexible Structures
P. F. Pai, B. Wen and M. J. Schulz
Direct Optimal Control of the Duffing Dynamics
H. Öz and J. K. Ramsey
Active Control of a Typical Section Using an Articulated Flap
J. S. Vipperman, R. L. Clark, M. Conner and E. H. Dowell

Nominear Dynamics in the Response of an Airfoll with a Loose Flap
L. N. Virgin, E. H. Dowell and M. D. Conner25
Robust Multivariable Flutter Suppression for the Benchmark Active Control Technology (BACT) Wind-Tunnel Model
M. R. Waszak
Active Control of Sound Transmission through Aeroelastic Structures
K. D. Frampton and R. L. Clark
Active Control of Noise Transmission through Flexible Panels with Constrained Layer Damping
B. Balachandran, A. Sampath and CW. Ahn
Nondimensional Analysis of Semi-Active Electrorheological and Magnetorheological Dampers Using Approximate Parallel Plate Models
N. M. Wereley, L. Pang
\mathbf{H}_{∞} Control of Active Constrained Layer Damping
J. Crassidis, A. Baz and N. Wereley
Magnetic Constrained Layer Damping
A. Baz33
An Optimal Perturbation Approach to Stability Robustness of Aeroelastic Systems
G. A. Bécus34
Active Flutter Control: Time-Domain Controller Design
W. R. Saunders, D. G. Cole, R. R. Soper and D. T. Mook
Suppression of Flow Induced Oscillations Using Sloshing Liquid Dampers
M. L. Seto and V. J. Modi
On Modeling Layered Media for Damping Treatments
E. M. Austin and D. J. Inman
Experimental System Identification and Active Vibration Control of a Smart Machine Tool
J. Pratt and A. H. Nayfeh389
Closed-Loop Analysis of Active-Passive Hybrid Piezoelectric Networks
M. S. Tsai and K. W. Wang

A Hydrostatic Robot for Marine Applications	
R. Vaidyanathan, H. J. Chiel and R. D. Quinn543	1
Translational Control of the NASA Three Degree of Freedom Reaction Compensation Platform	
C. E. Birkhimer and W. Newman, B. Choi and C. Lawrence	
Planar Dynamics and Control of Flexible Manipulators with Deployable Links	
M. Caron, V. J. Modi and A. K. Misra563	
Input Shaping for Collision Avoidance with Robotic Manipulation of Suspended Payloads	
H. Jacob, S. Feder, W. E. Singhose and W. P. Seering	
Definition of the Mini Pressurized Logistic Module (MPLM) Test Analytical Model (TAM) to Better the Chances of Conducting an Adequate Modal Survey Test	
M. Bellini and P. Fleming	
Adaptive Control of Space Structures: An Experiment Based on Recurrent Neural Networks	
F. Bernelli-Zazzera and V. Lo-Rizzo	
Sliding Mode Control of a Large Flexible Space Structure	
M. Allen and R. Scattolini and F. Bernelli-Zazzera	
Semiactive Control of Multibody Systems	
M. Ahmadian, X. Song and B. A. Reichert	
Gait Generation and Obstacle Avoidance of an Autonomous Six-Legged Walking Machine	
P. Bührle, J. Wauer and S. Cordes	
Design of a Cockroach-Like Hexapod Robot	
R. J. Bachmann, G. M. Nelson, W. C. Flannigan, R. D. Quinn, J. T. Watson and R. E. Ritzmann 647	
Stabilizability of an Antagonistic Biomimetic Actuator System	
R. M. Kolacinski and W. Lin655	
Structural Analysis of Instrumentation Aboard the ER-2 Used for Atmospheric Testing	
P. D. Jones, P. M. Bainum and G. Xing	
Optimal Sensor and Actuator Placement for Structural Control Based on Output Controllability	
B. Dunn and E. Garcia	

Professor M. Ahmadian
Dept. of Mechanical Engineering
VPI&SU
Campus 0238

Dr. K. K. Denoyer USAF Phillips Laboratory PL/VTVD Bldg. 472 3550 Abordeen Ave., SE Kirland AFB, NM 87117-5776 Professor D. J. Leo The University of Toledo Mechanical Industrial & Manuf. Engr. Nitschke Hall Toledo, OH 43606-3390

Professor M. Ahmadian Dept. of Mechanical Engineering VPI&SU Campus 0238 Professor E. Garcia Dept. of Mechanical Engineering Vanderbilt University 1592 Station B Nashville, TN 37235 Professor S. O. R. Moheimani School of Electrical Engineering Australian Defence Force Academy Canberra, ACT 2600 AUSTRALIA

Professor G. A. Bécus ASE/EM Dept. ML 0070 University of Cincinnati Cincinnati, OH 45221-0070 Professor M. F. Golnaraghi Dept. of Mechanical Engineering University of Waterloo Waterloo, Ontario CANADA N2L 3G1 Professor H. Öz
Dept. of Aerospace Engineering,
Applied Mechanics and Aviation
The Ohio State University
Columbus, OH 43210

Professor K. Behdinan Dept. of Mechanical Engineering PO Box 3055, MS 8895 University of Victoria Victoria, B.C., V8W 3P6, CANADA

Professor L. Librescu ESM Dept. Virginia Tech Campus 0219 Professor P. F. Pai Dept. of Mechanical Engineering North Carolina A&T State University Greensboro, NC 27411

Professor V. Berdichevsky Dept. of Mechanical Engineering Wayne State University Detroit, MI 48202

Dr. J. W. Grant Bently Rotor Dynamics Research Corp. 1711 Orbit Way, Bldg. 1 Minden, NV 89423 Dr. C. Papadimitriou Civil Engineering Dept. Div. of Engr. & Applied Sci. 104-44 California Institute of Technology Pasadena, CA 91125

Professor P. Bührle Institut für Technische Mechanik Universität Karlsruhe Kaiserstrasse 12 76128 Karlsruhe GERMANY

Dr. B. H. Houston Naval Research Laboratory Physical Acoustics Branch, Code 7130 Washington D.C. 20375 Dr. B. Pokines Vanderbilt University Box 1592, Station B Nashville, TN 37235

Professor W. Dehandschutter KULeuven, Dept. Mechanical Engineering (PMA) Celestijnenlaan 300 B, B-3001 Heverlee BELGIUM Dr. A. Z. Khan
Dept. of Civil Engineering
City University
Northampton Square
Lond EC1V OHB, UNITED KINGDOM

Professor A. H. Nayfeh ESM Dept. Virginia Tech Campus 0219

Professor Ravi Vaidyanathan Professor A. V. Balakrishnan Professor L. Silverberg Mechanical and Aerospace Engineering Mechanical Engineering 56-125B Engineering IV Building Case Wester Reserve University North Carolina State University 405 Hilgard Avenue Cleveland, OH 44106-7222 Raleigh, NC 26595-7910 Los Angeles, CA 90024-1594 Professor C. F. Reinholtz Professor A. V. Balakrishnan Professor Craig Birkhimer 56-125B Engineering IV Building Mechanical Engineering Dept. Electrical Engineering Dept. 405 Hilgard Avenue Virginia Tech Case Western Reserve University Los Angeles, CA 90024-1594 Campus 0238 Cleveland, OH 44106 Professor Hartmut Bremer Professor M. J. Schulz Dr. William Singhose Mechatronics Institute - Chair of Robotics Mechanical Engineering Dept. 77 Mass. Ave., 3-438A Johannes Kepler University North Carolina A&T State University Cambridge, MA 02139 Altenbergerstr. 69, A-4040 Linz Greensboro, NC 27411 AUSTRIA Professor C. A. Mendes Vercosa Professor Faryar Jabbari Professor P. M. Bainum Departamento de Engenharia Mecânica Mechanical & Aerospace Engineering Dept. of Mechanical Engineering Universidade Federal de Pernambuco University of California, Irvine Howard University Centro de Tecnologia e Geociencias Irvin, CA 92697-3975 Washington, DC 20059 Recife - PE 50 740 530 BRASIL Dr. Rush D. Robinett Professor P. Benson Shing Professor V. J. Modi MS 1003 Civil, Environ. & Archit. Engineering Dept. of Mechanical Engineering Sandia National Laboratories University of Colorado University of British Columbia P.O. Box 5800 Boulder, CO 80309-0428 Vancouver, B.C., CANADA Albuquerque, NM 87185 Professor V. J. Modi Professor Farid Amirouche Professor Satish Nagarajaiah Dept. of Mechanical Engineering Mechanical Engineering Dept. Dept. of Civil Engineering University of British Columbia University of Illinois-Chicago University of Missouri-Columbia Vancouver, British Columbia 2027 ERF Columbia, MO 65211 CANADA V6T 1Z4 842 W. Taylor Street Chicago, IL 60607

Professor H. Baruh Mechanical & Aerospace Engineering Rutgers University Piscataway, NJ 08855-09009

David G. Wilson 1907 Buena Vista S.E. #80 Albuqerque, NM 87106 Professor Raimondo Betti Civil Engr. & Engineering Mechanics Columbia University New York, NY 10027 Professor Michael D. Symans Dr. Martin Waszak Professor A. Fregolent Civil & Environmental Engineering MS 132 Dipartimento di Meccanica NASA Langley Research Center Washington State University e Aeronautica Pullman, WA 99164 Hampton, VA 23681-0001 Universita di Roma "La Sapienza" Via Eudossiana, 18 00184 Rome **ITALY** Professor M. I. Friswell Professor William R. Sanders Professor Henri Gavin Mechanical Engineering Dept. Mechanical Engineering Dept. Dept. of Civil Engineering University of Wales Swansea Virginia Tech Box 90287 Singleton Park Campus **Duke University** Swansea SA2 8PP Durham, NC 27708-0287 Wales, UNITED KINGDOM Professor J. Q. Sun Professor Robert L. Clark Mechanical Engineering Dept. Mechanical Engineering & Materials Sci. Professor M. P. Singh University of Delaware **Duke University** ESM Dept. Newark, DE 19716 Durham, NC 27708-0300 Virginia Tech Campus 0219 Professor J. Q. Sun Professor Andrew J. Kurdila Mechanical Engineering Dept. Aerospace Engineering Dept. Dr. Mike Riley University of Delaware Texas A&M University Dept. of Civil Engineering Newark, DE 19716 College Station, TX 77843-3141 212 Ketter Hall SUNY Buffalo, NY 14260-4300 Professor J. Q. Sun Professor J. Swevers Mechanical Engineering Dept. Mechanical Engineering Dept. University of Delaware Katholieke Universiteit Leuven Professor J. N. Yang Newark, DE 19716 Celestijnenlaan 300 B Civil & Environmental Engineering B3001 Heverlee, BELGIUM University of California, Irvine Irvine, CA 92697-2175 Dr. K. W. Wang Struc. Dynamics & Cont. Research Lab Professor M. W. Zehn Mechanical Engineering Dept. Otto-von-Guericke-Universitaet Magdeburg Professor Robert L. Clark Pennsylvania State University Institut fur Mechanik Mechanical Engineering & Materials Sci. University Park, PA 16802 Universitatsplatz 2 **Duke University** D-39106 Magdeburg, GERMANY Durham, NC 27708-0300 Professor A. Fregolent Professor B. Balachandran Dipartimento di Meccanica Smart Materials and Professor E. H. Dowell e Aeronautica Structures Research Center School of Engineering Universita di Roma "La Sapienza" Mechanical Engineering Dept. **Duke University** Via Eudossiana, 18 00184 Rome University of Maryland Durham, NC 27708-0300 **ITALY** College Park, MD 20742-3035

Professor N. M. Wereley Aerospace Engineering Dept. University of Maryland College Park, MD 20742 Mr. M. Bellini Corso Marche 41 10146 Torino, ITALY

Professor A. Baz Mechanical Engineering Dept. The Catholic University of America Washington, DC 20064 Professor B. F. Spencer Civil Engineering & Geological Sci. University of Notre Dame Notre Dame, IN 46556

Professor A. Baz Mechanical Engineering Dept. The Catholic University of America Washington, DC 20064

Professor M. Allen Università degli Studi di Pavia 27100 Pavia, ITALY

Dr. F. Bernelli-Zazzera Politecnico di Milano Dipartimento di Ingegneria Aerospaziale Via Golgi 40-201 33 Milano, ITALY

Professor F. Casciati Dept. of Structural Mechanics University of Pavia Via Ferrata 1 27100 Pavia, ITALY

Professor F. Casell
Dipartimento di Elettronica e Informazione
Politecnico di Milano
Piazza L. da Vinci
32-20133 Milano
ITALY